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BACHELOR THESIS

Vendor lock-in in IT procurement

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature. This thesis was not used to obtain any other academic degree.

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Abstract

The paper concerns with vendor lock-in in public procurements on information and communication technologies (ICT), examined it in general and theoretically handle how it could be prevented. The primary aim of the study is to find out if some criterions of public procurements lead to higher lock-in rate or not and if higher vendor lock-in rate leads to the higher profit of the suppliers. The results showed that higher number of bids in the initial procurements leads to lower lock-in rate. On the other hand, the hypotheses about the European Union (EU) funds and the price criterion were not proved. Also, we have not proved the hypothesis that higher lock-in rate leads to the higher profit of the suppliers. Another finding of the paper is that public sector suffers from the oldness of the information systems. Plenty of the information systems is older than 11 years old. That is also the reason that many initial procurements for the information systems are not available in the dataset (it is related to at least 148 information systems). That is the reason for our quite small sample and could be the reason for the results we got. The recommended steps, to lower the level of lock-in, include the creation of the ICT strategy, guidance to contract documentation and a request to suppliers to use open standards and open source software.

JEL Classification	C12, C14, H57, L17, L86
Keywords	public procurement, IT, vendor lock-in

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Abstrakt

Práce se zabývá vendor lock-inem ve veřejných zakázkách na informační a komunikační technologie (ICT), zkoumá ho obecně a teoreticky řeší, jak by se mu dalo předcházet. Hlavním cílem práce je zjistit, zda některá kritéria veřejných zakázek vedou k vyšší míře lock-inu či nikoliv a zda vyšší míra vendor lock-inu vede k vyššímu zisku na straně dodavatelů. Výsledky ukázaly, že vyšší počet nabídek u původních zakázek vede následně k vyšší míře lock-inu. Naopak hypotézy o EU fondech a cenovém kritériu nebyly prokázány. Také se neprokázala hypotéza, že vyšší míra lock-inu vede k vyššímu zisku dodavatelů. Dalším zjištěním práce je, že veřejná správa trpí velkým stářím informačních systémů. Mnoho informačních systému je starší 11 let. To je také důvod, proč mnoho původních zakázek k informačním systémům nejsou dostupné v datasetu (jedná se minimálně o 148 informačních systémů). To je důvod našeho malého vzorku a může být důvod pro výsledky, které nám vyšly. Doporučující opatření k snížení míry lock-inu obsahují vytvoření ICT strategie, doporučení pro dokumentaci k veřejným zakázkám a požadavek na dodavatele, aby využívaly open standards a open source software.

Klasifikace JEL	C12, C14, H57, L17, L86
Klíčová slova	veřejné zakázky, IT, vendor lock-in

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Contents

List of Tables

List of Figures

Acronyms

CIO Chief Information Officer

CZK Czech Koruna

EU European Union

ICT Information and Communication Technologies

IPR Intellectual property rights

ITD Information Technology Division

NPWP Negotiated procedure withnout publication

NPWP* Negotiated procedure with publication

ODF Open Document Format

OLS Ordinary Least Squares

OOXML Office Open Extensible Markup Language

SAO Supreme Audit Office

SME Small- and Medium-sized Enterprise

Bachelor Thesis Proposal

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Proposed topic	Vendor lock-in in IT procurement

Characteristic of the topic Práce se bude zabývat zadáváním IT zakázek ve veřejném sektoru. Primárně se bude soustředit na vendor lock-in, co je s ním spojeno za problémy a jak by se mu dalo předcházet a na jeho identifikaci v datech. V práci bude použit kvantitativní výzkum, který bude zkoumat hypotézy na základě dat za Českou republiku a Slovenskou republiku. Hlavním cílem práce bude navrhnout metodiku pro identifikaci vendor lock-inu v datech a měření jeho nákladů.

Tato metrika bude použita k testování hypotéz:

- otevřená soutěž cenou vede častěji k lock-in situacím
- projekty podpořené z EU fondů vedou častěji k lock-in situacím
- Vendor lock-in vede k vyšší ziskovosti dodavatelů

Outline

1. Introduction
2. Public procurement on IT
3. Vendor lock-in
4. Empirical analysis
5. Discussion of Results
6. Conclusion

Core bibliography

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1 Introduction

Public procurements are a field of interest where billions of Czech Crowns are spent each year. In the Czech Republic, there was spend 556[1] bn CZK in the public procurements in 2015. It represented almost 29% of all public spending in 2015. Despite the increasing presence of this topic in public debate, too little research devoted to the public procurements exists.

This paper is concretely focusing on the public procurements on information technologies and connected vendor lock-in. It is problem which does not trouble only the Czech Republic but it troubles all the European Union. According to the Commission (6/2013a), public sector in the EU loses around €1.1 billion per year due to this problem. In the Czech Republic some of the public procurements, which suffer some level of lock-in, are publicly well-known. The most known are probably Opencard (system for the public transportation), the collection of toll or information system State Treasury.

The primary aim of this study is to figure out if some criterions of the public procurements lead to higher vendor lock-in rate or not and if higher vendor lock-in rate leads to the higher profit of the suppliers. Our hypotheses focus on the criterions like EU funds, competition by the price criterion or number of bids. The paper also brings some basic description of the procurements between July 2006 and July 2016. The description is based on criterions like procedure type, EU funds or price criterion.

The thesis is structured as follows. Chapter 2 includes literature on public procurements on ICT, connected vendor lock-in and papers focusing on open source and open standards. Chapter 3 brings some general knowledge about vendor lock-in. It also includes some real examples from the Czech Republic and European countries. Chapter 4 is devoted to the procurement practices on ICT in the EU based on the information from the survey among procurers and suppliers. Chapter 5 deals with some ways how vendor lock-in could be prevented. It mentions parts like ICT strategy, contract documentation and works with open standards and open source. Chapter 6 focuses on the empirical analysis including the description of the data, calculation of lock-in, hypotheses and their motivation and also the discussion of the results. Finally, chapter 7 concludes.

[1]The Ministry of Regional Development, Accessed: 2017-04-23, http://www.portal-vz.cz/getmedia/07d1ec0c-cf7b-4895-8762-4b283d04b4c4/Vyrocni-zprava-o-stavu-VZ-v-CR-za-rok-2015.pdf

2 Literature overview

There are four strands of literature in this paper. First, the materials, from the European Commission and Czech economic think tank EconLab, on public procurements and vendor lock-in. Second, the papers which focus on open-source software and open standards and how the use of these could be helpful in public offices. Third, the examples of vendor lock-in from the Czech Republic and an experience from Massachusetts where they tried to adopt open standards in public offices in order to save money and be more flexible. And the last type of source is Czech public procurement Act.

The European Commission has two papers, Economics (2012a) and Economics (2012b), which focus on the public ICT procurements. There are presented results from the survey which was made among the public procurers and suppliers in the EU. Also, procurement practices, using of standards and some recommendations from suppliers and procurers to prevent vendor lock-in are involved in these papers.

Another two papers from the European Commission, Commission (6/2013a) and Commission (6/2013b), deal with vendor lock-in, connected problems and some advantages which avoiding lock-in could bring. The former paper includes some general numerical estimates and comparison of ICT systems based on standards and proprietary systems. According to this paper, public sector loses around € 1.1 billion per year due to lack of competition and referring to brand names which lead to higher prices. The later paper is dedicated to the advice or recommendations how ICT procurements and documentations should be done. It is engaged in the ICT strategy, practical advice, assessing standards, ICT needs, procurement documentation, long-term business appraisal and budgetary planning.

The paper, Centrum aplikované ekonomie (8/2014), studies the public procurements which are placed without competition, so-called NPWP. The study compares the frequency of this process, compares the Czech Republic with other European countries and shows the frequency of the stated reasons for this procedure.

The second strand of literature is dedicated to the open-source software and open standards. Zhu & Zhou (2012) is focused on open-source software. It examines if a lock-in strategy benefit proprietary software, which faces competition, or open-source software, which can commit to future prices. The study proves with a two-period duopoly model that lock-in strategy in counterproductive when competes against open-source software. Study also finds broader effect that lock-in reduces overall social welfare.

Another paper, Committee (4/2006) focuses on openness and connected open standards, open-source and open innovation. It examines the "openness", what it really means, the

connection with today's digital economy and if it should be encouraged or restricted by public policy.

The third strand of literature focused on the examples of vendor lock-in and Massachusetts' experience. A case study from Massachusetts, Shah *et al.* (2007), describes the process, which the state had to go through when tried to adopt open standards for its electronic documents. The case study describes the process as a struggle between the supporters of openness and providers of proprietary standards. Massachusetts is described as the first U.S. state to adopt open standards policy which encouraged other U.S. states or the United Kingdom to support open standards.

The internet journal Dotyk, Pšenička (2016), describes the examples of vendor lock-in from Czech environment. The author writes about the most notorious IT procurements like the collection of toll, data boxes, Prague's Opencard, ADIS (information system for taxes) or the Monitoring system of the European funds for years 2014-2020.

The last source of literature is the public procurement Act which helps us to describe different procedure types and their possibility of usage.

3 Vendor lock-in

This chapter is about vendor lock-in in IT in general. It brings some general definitions and ways how the company can lock-in to the supplier. There are also some examples both from the European countries and from the Czech offices or ministries. The last thing which is mentioned in this chapter is Massachusetts experience. This part focuses on the process which the state went through trying to adopt open standards and open-source software in the government offices.

3.1 What it is and which problems it brings

Vendor lock-in is a general term for locking yourselves to a single supplier or a small group of suppliers. In Economics (2012a) it is described as *"long-term dependence on a particular vendor or supplier beyond the boundaries of individual procurement actions."*

We focus on vendor lock-in in information technologies (IT) because according to the sources Economics (2012a) and Commission (6/2013a) it is seen as risky and expensive. According to Commission (6/2013a) it is estimated that due to lock-in some 1.1 bn EUR per year is lost unnecessarily in the public sector in the European Union (EU). According to Shah *et al.* (2007), the lock-in is problematic due to the switching costs: *"Vendor lock-in is a facet of the IT market and occurs whenever customers buying choices are tied to an original purchase for related product. Significant switching-costs are the essential component to vendor lock-in, which prevents real user choice and flexibility."*

The suppliers try to get into lock-in situation because they acquire a long-term deal which guarantees a certain profit. According to Klemperer (1987), a paper which considers two-period duopolistic competition, each firm would like to give up its first-period profit for its second-period gains at the margin. Another reason is that with lock-in supplier can be in better position than a customer. According to Zhu & Zhou (2012) *"vendor lock-in may reduce the bargaining power of customers and increase that of vendors in the postadoption period; proprietary vendors may gain competitive advantages (or even monopoly power) from a lock-in strategy."*

According to Zhu & Zhou (2012), a company can lock-in to their customer in several different ways:

- *"Designing a system incompatible with software developed by other vendors.*
- *Using proprietary standards or closed architecture that lack interoperability with other applications.*

- *Licensing the software under exclusive conditions."*

In some cases when trying to change the system or supplier, the procurer still needs the cooperation of the supplier. There are many situations when the customers are dependent on the suppliers. Below we try to list some of the reasons and show some real examples.

- Author rights: The rights to the system are not in the ownership of the public authority. The solution could be the purchase the system but the amount of money can be substantial.
  - The example can be the Prague's Opencard (system for public transport) when the supplier offered the purchase of the system.
- Data: The data from the system owns the supplier and they are necessary for the public authority.
- Source codes: The public authority has to deal with the supplier to make the source codes of the system available for the purpose of the open competition (this situation can be connected with another prolongation of the contract for additional year or years and working on the competition during that time).
  - The example can be the competition to the collection of toll. The contract was prolonged for 3 years and the competition should happen during that time.
- HW infrastructure: The HW is necessary for another operation of the system but the owner is the supplier.
- Lack of documentation: The documentation to the system is held by the supplier and not by the public office.
- "Monopoly" creation: The system is not used only by one public authority but it is used e.g. by all ministries or all city districts.
  - The example can be the ministries in Finland: The application for the preparation of documents for the cabinet decision is shared by all ministries. The system is based on proprietary file formats and has to be supported by all ministries. So it creates large monopoly.[1] (This is similar to something that made the city of Prague. The licenses for the accounting program from the company Gordic were bought by the city of Prague for all city districts.)
  - Document formats and documents owned by Swedish municipalities found that in many cases the files could not be opened in applications other than those from the same provider as the original one (even supposedly open file formats), thus requiring the municipalities to continue using the proprietary applications in order to access their files. [2]

[1]Source of this example is Commission (6/2013b)
[2]Source of this example is Commission (6/2013b)

3.2 Examples from Czech environment

Now, we have basic knowledge about lock-in and we know about some situations when the procurers are dependent on the suppliers. Now we look at some Czech procurements which belong to the biggest (financially) and, thanks to them, the expenses were much higher in years 2009 and 2013 than other years (see Figure 6.1 in chapter 6.1.2).

- The Ministry of the Interior and Data-Mail Boxes: In 2009, the Ministry of the Interior had a contract with Czech Post Office (state company) for the Information System of Data-Mail Boxes (ISDS). According to the law from 2008, the keeper of this system has to have the post license. Data mail-box is an electronic box (similar to e-mail box) which is used to communicate and send documents to the government. But Czech Post Office is buying the services from the O_2 Company and is not developing or operating the system by itself. Since 2014, there is a regular fee 605 million CZK for the services which are the Ministry buying from Czech Post Office. Since 2009, the project cost almost 5 billion CZK.
- The Ministry of Regional Development and System for the European Funds: TESCO SW acquired the contract for the Monitoring system of European funds for years 2014-2020. This procurement was investigated by the anticorruption police because some parameters in the procurement were identical with another competitor. This company developed the system for previous years and the procurement was in conflict with the law.
- The Ministry of Finance and State Treasury: This system was supplied by the IBM company. According to the SAO (2012), some of the procurements connected with this system were placed in conflict with the law through the NPWP. The system cost over 3 bn CZK. Nowadays, the system is managed by another company but due to the lack of documentation, the system is not further developed.
- The Ministry of Finance and ADIS: IBM is the supplier of the information system for taxes (ADIS) since the year 1992. Since that there was not any competition of this system and the contract is prolonged without the competition through the NPWPs (Negotiated procedure without publication).[3] Also, other parts are integrated into the current system. For example, the system EET (electronic cash registers for businesses) was implemented in 2016 without competition.

As we can see the biggest contracts are placed or prolonged without competition, through the NPWP. This could be the reason for the creation of lock-in or its deepening (as implementing EET into ADIS).

[3]Explanation for usage of NPWP is in chapter 6.1.1. Basically, it is procedure without competition for certain supplier.

3.3 Massachusetts experience

Next, we look at the U.S. state which tried to switch from proprietary software to an open standard as the first government. The state government wanted to have more control and autonomy over the information technologies in order to avoid vendor lock-in and save money. Thus, in 2003, the state government made a decision on a policy to transition to open standards.

For this policy, the open standards were defined as same as in Fitzgerald *et al.* (2011): *"specifications for systems that are publicly available and are developed by an open community and affirmed by a standards body. Hypertext Markup Language (HTML) is an example of an open standard. Open standards imply that multiple vendors can compete directly based on the features and performance of their products. It also implies that the existing information technology solution is portable and that it can be removed and replaced with that of another vendor with minimal effort and without major interruption."*

The plan started in 2003 when the Secretary of Finance and Administration authorized the Chief Information Officers (CIOs) in Massachusetts to make a plan to switch to open standards in state's IT systems. The principal motivation was to save money and increase efficiency in state's IT expenditures. In 2004, the framework, which would be implemented by the Massachusetts Information Technology Division (ITD), for this policy was released. In the statement, there was explained what the policy should do: *"prevent vendor lock-in, keep maintenance and acquisition costs down, and gain the ability to switch to differing software suites without having to concern itself with cumbersome switch-over costs resulting from proprietary issues."*

In August 2005, a policy draft was released by ITD. Till this time, the government saved the electronic files in many different formats often created by Microsoft. But the formats were not compatible with each other. The draft required that since January 1, 2007, all documents use open standards document formats, Adobe PDF file or the Open Document Format (ODF). Massachusetts became the first state government in the United States who supports only open standards. A report, presented to the World Bank, supported this as a vital step to accelerate economic growth, efficiency, and innovation.

This decision also led to a public critique by Microsoft. According to them, the ODF is an immature format and it will lead to confusion and incompatibility. Later the Computer Technology Industry Association joined the criticism. The critique could be summarized to three points. First, they questioned saving money with this policy. The second point was the poor quality of open standards. The last point concerned about innovative companies who would be discriminated if they created their own proprietary format.

In November 2005, Microsoft announced the creation of Office Open Extensible Markup Language (OOXML). The Administration and Finance Secretary, under new management, announced that the new OOXML meet their demands for open formats. However, supporters of open standards were skeptical about this, saying that it was not truly open and the state should move back to support the ODF. For half a year the environment was quiet. But in March 2006, disability advocates strongly concerned about switching to ODF because Microsoft's Office is disability-friendly software. Despite the protests, the government still supported the original plan. And surprisingly in July 2006, the Microsoft announced to

implement the ODF standard to government's computers and would release plug-in programs to make the transition easier. However, the implementation took some delay and it led to the resignation of the head of the ITD in October 2006. The new head of the ITD stated that the testing would take nine months. The Microsoft's plug-in was ready in January 2007. A major policy change came out in January 2007. The CIO announced that both OOXML and ODF would be acceptable as open formats.

We can take some lessons from this experiment of implementing open standards. When implementing this policy there is the need for government to support the policy in financial, logistical, technical, and political terms; and the knowledgeable IT team. The government also need to look up for help from both within government and open standards community. Despite the pressures from the Microsoft company, the government kept going to support the open standards. This resulted in the creation of the OOXML by Microsoft which is used in their Microsoft Office package since 2007. So when Massachusetts government tried to adopt the policy for escape vendor lock-in it led to the creation and expansion of the open standards. And as a result of this policy, other governments in the United States or the United Kingdom were encouraged to adopt the open standard policies. (See Committee (4/2006) or CabinetOffice (11/2004).)

4 Public procurement on IT

We have the basic notion about vendor lock-in and we had some examples of it from Czech environment and Massachusetts experiment where they adopt open software instead of proprietary one to avoid lock-in. Now we can look at the procurement practice in the EU based on the information from procurers and suppliers and see what the problems according to them are.

4.1 Current procurement practice in the EU

This chapter describes the procurement practices on ICT across the EU based on the information from the survey, Economics (2012b), among the procurers and suppliers. The survey was made in 2011. The procuring authorities are represented by 244 procurers from all 27 Member States. The suppliers of the ICT services were represented by 172 respondents from all but three Member States. Ten interviews are also included in the responses with additional information.

The information from the survey explores three main areas:

- Identifying and specifying the ICT need: This area focuses on objectives of ICT and on the documentation of the ICT procurements, how it is written and what are the problems in tenders according to suppliers.
- Lock-in and Legacy systems: This part is devoted to the information about lock-in experience, its' main sources and the problems of changing the systems.
- Interoperability and use of standards: This paragraph describes how often the interoperability and some standards are required.

4.1.1 Identifying and specifying the ICT needs

The majority find maximizing competition as extremely important or important - 68 per cent. There was found a relationship[1] between maximizing competition and open tenders in the answers of the survey *"Procurers for whom maximizing competition was an important consideration were more likely to write open tenders using technology-neutral language than procurers who did not consider competition important."*

According to suppliers, the tender specifications have several problems:

[1] 10 per cent significance level

- Poorly written tender specification. Requirements for the ICT are either too vague or too technically detailed which reduce the way for innovation or alternative solution.
- Functional description (no description what the ICT should do) or request for over-customised solutions which often require new elements.
- Participation of SMEs or new market entrants is restricted by requirements like a specific number of years in business, long delivery records or trading volumes.
- Demanding certain standards, specification or specific product.

This is a problem because it restricts alternative solutions. Public authorities should ask for the requirements but not for the specific solutions because companies could bring innovative solutions.

From the survey of public procurers on the tender writing process, we have quite optimistic results. Almost 80 percent of procurers try to write, always or often, open tenders using technology-neutral language and 70 percent of procurers, sometimes or never refer to specific brand names or suppliers. However, responses from the suppliers' survey are not so positive. 56 percent of suppliers experience, at least sometimes, difficulties in engaging with public procurement. The public sector can restrict the competition by writing to the tender some specific demands. Almost 60 per cent of suppliers say that tenders either always or often refer to very specific technology that only a few suppliers can provide, and the boundary of 50 per cent of respondents also cross the tenders which refer to proprietary technical specification. On the contrary, 35 per cent of suppliers says that tenders often refer to brand names. It could seem that it is not much, but demanding some specific brand can lead to higher probability of future lock-in, forming a monopoly or a risk that a provider can decide to stop supporting the system or some features of the system. According to the Commission (6/2013a): *"References to brand names are allowed only on an exceptional basis, where a sufficiently precise and intelligible description of the subject-matter of the contract using is not possible by other means laid down by Union legislation; such reference shall be accompanied by the words "or equivalent"."*

So, from this, we can conclude that suppliers and public authorities have different opinions. A possible explanation could be that public authorities have a lack of expertise. When they think that they use the technology-neutral language or do not refer to specific brand names it is possible that it is not true.

4.1.2 Lock-in and legacy systems

Survey further concludes that 40 per cent of procurers considers themselves locked-in to their current ICT suppliers. Almost 40 per cent [2] of procuring authorities say that changing the brand of their ICT solutions would be too costly as other systems need to be adapted as well and 34 per cent say that it would be too costly because they are trained to use a particular brand. Also, 25 per cent of respondents thinks that they would not be able to change their ICT system because the data cannot be transferred and they would lose the information which can imply a lack of openness of data formats.

[2] same 40 as in previous case - 40 per cent of the same base

From the procurers' and suppliers' survey, the sources of lock-in are connected with: software, database systems, and bespoke solutions. Software lock-in is linked to an inability to transfer the data to the new system. Database systems lead to lock-in because they do not integrate well with other systems from other vendors. And bespoke solutions are connected with lock-in because the ICT is largely linked with the specific technical knowledge and lack of proper documentation with the history of the system.

The interviews indicate that the tenders could be made more open if the procurers would provide detailed documentation on the existing systems and underlying code, where available. Interviews also show that some organizations suggested migrating to open source software but it was too costly. They also indicate that there is a lack of political will and sometimes managerial skills to organize this (The Massachusetts experience, in chapter 3.3, is a good example that the political will is needed for these policies.).

For the majority of procurers, 93 per cent, is important the compatibility of new ICT with existing systems. Suppliers confirm this experience and also say that it restricts their ability to participate in the tender, with 23 per cent yes and 46 per cent sometimes. As it is said in Economics (2012b): *"This suggests that compatibility requests from procurers often refer to specific proprietary products that certain suppliers were not able to provide, which could increase the likelihood of the procuring authority being continually locked-into the original vendor products."* Some suppliers also say that public procurers request open data formats, 18 per cent often and 31 per cent seldom.

All these information from the survey stated above are in agreement with the reasons of lock-in we stated in chapter 3.1 - costly change of ICT solutions (e.g. proprietary software), inability to change the system due to the problem with data transfer (proprietary data formats), lack of documentation (unknown history of the system).

4.1.3 Interoperability and use of standards

Interoperability is an ability of the system to use the parts of another system. The request for interoperability is cited by 70 per cent of procuring authorities. The common way is, according to 16 per cent of respondents, specifying the existing systems or products that must be compatible with new ICT systems. The suppliers answer that the interoperability is required in high frequencies: 17 per cent always and 60 per cent often.

67 per cent of procurers responded that they use the standards always or often. From the side of suppliers, it is a quite similar answer, 52 per cent public authorities refer to standards. The disadvantage for the use of standards can be the restriction of the ability of some suppliers to participate in tenders. The using of standards makes it easier for more suppliers to participate in the tender process according to 30 per cent of procurers. 40 per cent say that it is simpler to identify the requirements of the ICT compared with detailing the technical specifications.

Here we can find some contradiction. Almost 70 per cent of procurers responded that they use some standards. But 70 per cent of procurers also answered that they try to use technology-neutral language and do not refer to specific brand names. This contradiction supports the statement, which we stated above, that public authorities have a lack of expertise.

5 Preventing vendor lock-in

In the previous chapter, we have learned some practice in ICT procurements. The most interesting are probably the use of certain standards or brand names. Public authorities claim that they try to use technology neutral language but according to the suppliers, the authorities refer to standards in half cases. And as we said it could be a problem with lack of expertise in public authorities.

This chapter focuses on various ways how the public authorities could prevent vendor lock-in to happen. It goes through several areas like the ICT strategy, what should be part of it, and the accessibility of the data. Another part of this chapter is dedicated to the contract documentation what should be included and also what should be excluded. This part also contains some recommendations from the ICT suppliers who participated in the EU survey. The last things, which are mentioned here, are open standards and open-source software. The advantages and the differences contrary to the proprietary standards and proprietary software are mentioned.

5.1 Developing ICT strategy and understanding ICT needs

According to the Guide for ICT procurement, (Commission 6/2013b), public office should have developed its own ICT strategy. It is one of the points to alleviate lock-in. The strategic direction which the ICT should go and further ICT decisions and purchases should meet the ICT strategy. There should be legal departments, IT managers and CIOs in the development of the strategy. But it can also include the procurers or the strategists from the public sector. The part of the strategy can be sharing and reuse of services among the public offices. The authorities should also consider which standards and technical specifications are in favor of the strategy, how the ICT procurements should compete within the offices and a plan for resolving the vendor lock-in.

When purchasing the ICT there should be several considerations. First, who will use the program or services, if only employees (internal program or software) or even public (e.g. public register for something or publicly used data). Second, consider if it is planned that the system will be connected to other systems and so the interoperability is needed. Next, understand the legacy systems which are used by offices for years and find out if there is a lock-in. Because if there is lock-in then the additionally connected programs can lead to narrow the competitors (or even narrow the competition to the original vendor) due to standards

in the original system. According to the (Commission 6/2013b): *"The cost of 'breaking the locks' of legacy systems can be significant in the short term but should be considered together with the future benefits of more open systems within the business appraisal. A long-term plan will be needed."* Another thing to consider is the accessibility of the data. The data have to be sometimes archived or used for a very long time period so they should be in a file format which does not rely on the original application or in an open file format, definitely not based on a proprietary format. And the last thing, but not the least, is that the contract does not lead the office to be tied with the specific supplier. Since the beginning of the competition, the documents should include the knowledge handover at the end of the contract period and it should be included in the original cost of the ICT procurement.

Example text from (Commission 6/2013b): *"In order to ensure that a competitive tender can be used to select another potential provider after the lifetime of the solution supplied under this tender, an anti-lock-in requirement must be met. All technical specifications, interfaces, protocols or formats implemented by the supplied solution and required for the full use of all data created or maintained using the supplied solution during its lifetime must be made available to providers of equivalent technologies who may be awarded a subsequent contract, with no additional costs. Any costs required for migration of data must be borne by the supplier of the supplied solution. Such costs may be minimized by ensuring that the supplied solution uses only, interfaces, protocols or formats that:*

- *Are implementable by all potential providers of equivalent technologies.*
- *Are developed through an open and transparent process.*
- *Have no restrictions on re-use, and require no payments for re-use."*

The text mentioned above, the example text, is text which should be included in contract documentation to avoid some type of vendor lock-in. This one is connected with possible data migration to future systems from a different provider. The (Commission 6/2013b) includes more of these example texts and also includes references to other sources of these example texts.

The part of the strategy can also be some list or text about practical advice. This should be developed mainly by CIOs and persons who see ICT needs of the organizations but other people like IT managers, procurement officials or end users are welcome. The people from other public offices can be part of it because they can share their own experience and make a suggestion based on their practice. The persons are quite similar as in the ICT strategy as a whole. The advice should include things like standards usage, avoiding the use of brand names or even (for smaller offices) making some templates. The part of it can also be a recommendation for IPR if the office would share the program with the other public authorities. And the offices should provide some training courses for their local public authorities or clerks in order to minimize the risk of lock-in and making the process of competition more open.

5.2 Contract documentation

This part is another point from the Guide for ICT procurement, (Commission 6/2013b), combined with the answers and recommendations from the survey, Economics (2012b), among suppliers.

In contract documentation, there should be met all the elements of best practices from the IT managers, procurements officers and even persons from the legal department. There should not be references to brand names, technical specification or proprietary standards in the documentation. The procurers should use the technology-neutral terms to describe the ICT product and also always try to demand open standards.

One possibility how the procurers could lower the chance of lock-in is that the procurements could be divided into more small procurements in order to avoid building giant ICT systems which would be locked to one supplier. This procedure should be done even if the entering costs will be adequately higher than the costs for the system from one supplier. It lowers the chance to locking yourselves to one supplier who would provide giant ICT system.

On the other hand, one thing which authorities should not do is competing ICT procurements by the lowest price. The lowest price criterion could be used in procurements for electricity but it should not be the main criterion for ICT services. ICT procurements should be evaluated according to quality, interoperability, user-friendly control or using the open standards or open source software.

In the survey, which was mentioned above, suppliers suggest how the tendering process could be made more open.

- *"Tenders should specify in tender calls the main problem for which they seek a solution, in order for suppliers to list the possible solutions, instead of tenders asking for a specific solution themselves, as this restricts innovation and can result in less optimal solutions. Suppliers believe that procurers should avoid asking for specific brand names, trademarks, and large supplier companies, and instead should focus on finding suppliers with more innovative solutions and lower costs of ownership than established firms."*
- The suppliers also mention the demand for dialogue between suppliers and procurers. The suppliers then could better understand what customer really need and develop for him a more feasible solution. It also increases the chance for small firms to participate.
- Some respondents also mention that tenders should always request open standards. It could lead at least to the consideration of open source software, which is usually provided by smaller companies.
- Avoiding the use of brand names or specific technical specification.

In the EU survey, the procurers and suppliers also mention some recommendations for use of ICT standards in tenders:

- According to the procurers in Economics (2012b): *"Help in accessing and using standards in tenders. This could include templates according to the categories of standards; online search tools with information on which standards are applicable to specific technologies; a database should be created where standards can be promoted according to specific types of products or technologies; the creation of a representative body, able*

to conduct, review and provide guidance to authorities, and both public as well as independent organizations which can help procurers to use standards." The public authorities should also share their experience in using standards in order to avoid vendor lock-in situations.

- Suppliers suggest that common standards like Open Standards ODF or XML should be implemented or even set up a mandatory use of Open Standards for ICT procurement and bring it together with national standards. Other suppliers, on the other hand, suggest that using whichever standards can restrict competition so instead of standards the procuring authorities should use functional specification in order not to restrict the innovative solutions.

5.3 Open standards and Open source

The last part focuses on open-source software and open standards and their advantages in comparison with proprietary software and standards when they are used in public offices. The software or standards can be either proprietary, open or somewhere between these two possibilities. Proprietary standards or software can be modified only by the owner but open standards are available for anyone and open-source software can be modified by anyone and is available for everyone. According to the (Committee 4/2006), the principle of openness leads to better competition, transparency, efficiency, encourage innovation and lower long-term expenses in ICT.

5.3.1 Open Standards

First, important thing is that open standards are different from open source. As it is define in (Shah *et al.* 2007): *"Open standards should not be confused with "open source". Open source is a development model for software based on the public availability of the source code. While open source software typically relies upon and uses open standards, they are two different concepts."*

Open standards are standards which are available and accessible to everyone. The best example can be the Internet or the World Wide Web. When developing new standards, the more open the process and greater participation of firms, civil society or the purchasers of the technology, the more chance that the standards will not be the interest of only one firm or a couple of firms. Open standards also support competition, help to avoid vendor lock-in and can save expenses. (Committee 4/2006) describe open standards like this: *"Open standards facilitate competition among a multitude of suppliers by reducing barriers to entry. They are often favoured by customers who want to avoid being locked into obtaining goods and services from a particular firm that controls a proprietary technology; such a firm may eventually choose not to support the technology or may even go out of business. Competition among technology suppliers encourages the spread of the technology and stimulates further innovation by suppliers anxious to differentiate themselves. On the other hand, technology vendors have traditionally been attracted to standards based on proprietary technology, especially if they believe that a standard based on their own proprietary technology will be adopted in the*

marketplace and allow them to garner significant economic returns." Some people argue that open standards reduce the innovation. But supporters defend the standards that they prevent one firm or company from controlling the standard, make the competition easier and support innovation beyond the standards for the firms that want to be different. To put it differently, the companies do not compete on the field of standards but on the field of innovation. These innovations can lead to the basis of new open standards and that can lead to another round of innovations. Another plus is that open standards are often supported by SMEs, which do not have the patent portfolio that generates profit as large firms, so it is difficult for them to invent their own proprietary technology. Thus, according to the (Committee 4/2006), the government or the public offices should support the open standards because they support competitiveness and thus possible lower prices and public offices, as a major customer for ICT services, can benefit from the support.

5.3.2 Open Source

Now we look at the open source. The proprietary software's source code is not "open", e.g. it is not available for modification, redistribution or study purposes. The software is licensed and can be used only under particular conditions entered by the rights holder. On the other hand, the open source software is accessible by anyone so that it has the widest possible distribution and anyone can improve it. In (Zhu & Zhou 2012) it is described like this: *"Open source refers to free access, free distribution, and free modification of software source codes."* The participation of more people is an advantage because debugging and maintenance make about one-half the cost of creating and maintaining software so the larger group of people participate the more chance that the problems will be detected. Also, the expansion of the open-source software means more people will engage the problems and the group become more heterogeneous and again more chance that the bugs will be fixed. The open-source community is growing. In 2001, it had 200.000 registered participants and in 2006 it grew to 1.200.000, who worked on 100.000 projects.

Some supporters of the open-source software argue that governments should use or purchase only the open-source software. Their arguments are that the government would save money (lower IT expenditures); support the development of local programming resources; improve security, and probably the most important it would reduce the dependence on firm's proprietary software and thus lower the probability of lock-in. On the other hand, firms who develop proprietary software criticize open-source because they cannot compete with "free" software. But supporters defend the open-source software that it only supports competition. The examples are database systems (MySQL), web browsers (Mozilla's Firefox) or operating systems (Linux). The proprietary software is not replaced. Apple's OS X, Microsoft's Windows or Office package, or Google's Chrome are still major players in the market. Even some of the biggest companies like IBM or Google support the open-source software because they figured out that they can benefit from it. For example, IBM supports the operation system Linux with its employees to participate in the open-source projects and Google is using the open-source to improve their own products.

But the main advantage of open source is probably reduced dependence on vendors' proprietary software. Zhu & Zhou (2012) describes the advantages of open source like this:

"The main reason is that there is no forced upgrade, and the software can be supported by an open community, as opposed to a proprietary vendor. The competition in the open community reduces the price of supporting and maintaining the legacy software. In contrast, proprietary software vendors often release new versions of software, force customers to upgrade and make them more dependent on vendor support, or else the customer would be stranded with an outdated system."

(Committee 4/2006) argue that the government do not have to require open-source software only, but should identify critical governmental functions and secure open-source software with interoperability for them. If the government use one firm's proprietary software then there are two possibilities. First, there is the possibility of losing the interoperability when purchasing software from more suppliers, which is not desirable. (Committee 4/2006) describes the importance of interoperability: *"The importance of interoperability with respect to critical governmental functions is even clearer than the general benefits of interoperability provided by open standards. The competition enabled by interoperability lowers costs, increases the number of vendors, reduces lock-in, and encourages innovation by broadening the potential market for new applications. In particular areas such as healthcare, interoperability can provide the basis for improved care for the chronically ill, fewer medical errors, and dramatically reduced administrative costs."* And the second possibility is that the government will have only one supplier for these critical functions but then it will create an enormous monopoly and it will be largely economically inefficient. These identifications of critical governmental functions should be made by governments at all levels.

6 Empirical analysis

Now we have a theoretical background of vendor lock-in, some information about procurement practice in the EU and some advice how the lock-in could be prevented. This chapter focuses on our empirical analysis. It includes a general description of the dataset, characterization of differences between the different procedure types and some descriptive statistics. Next, it incorporates our selected sample for analysis, the description of calculated vendor lock-in, description of the hypothesis and then the discussion about the results.

6.1 Data description

The source of the dataset is the Bulletin of Public Procurements under the Information System on Public Contracts, which is under the administration of The Ministry of Regional Development. Since 2006, all public contracts, which fulfill the conditions of the Public procurement Act, are listed there. The data are sometimes incomplete and inaccurate but public authorities are not penalized for it.

The time interval of this dataset is from July 2006 to July 2016. The dataset consists of 13 003 ICT public procurements and the final price of these contracts is approximately 133.5 bn CZK (4.94 bn EUR [1]). The publication of the contracts is mandatory with the price bigger than 2 mil CZK and voluntary with the price lower than 2 mil CZK. The dataset includes:

- 5 483 contracts with the price lower than 2 mil CZK and their total final price is approximately 4 bn CZK (10 contracts have 0 as final price).
- 7 339 contracts with price the equal or higher than 2 mil CZK and their total final price is approximately 129.5 bn CZK.
- 181 contracts whose price is not filled out.

The contracts for this time period were placed by 1 152 public authorities and divided among 1 851 suppliers.

The contracts are, apart from other things, awarded according to the criterion type. There could be used only price criterion in the public procurement or there could be used multiple criterions. The price criterion was used in 8 954 procurements which correspond to 68.86% and multiple criterion types were used in 4 049 procurements which correspond to 31.14%. Thus, public authorities more compete just on the price. The procurements are also

[1] exchange rate 27 CZK/EUR

sometimes financed with the assistance of the EU funds. This was used in 4 138 procurements which are equivalent to 31.82%. So, approximately the every third public procurement was financed with the assistance of the EU funds.

For further analysis, the contracts which do not have filled out the price were removed from the dataset. Which leaves us 12 822 public contracts.

Next, there are 2 types of the data analysis: according to tender procedure type and according to time.

6.1.1 Analysis according to tender procedure type

This part focuses on the analysis based on the tender procedure type. There are several procedure types that can be used in the competition. The detailed description and usage of different procedure types are in the public procurement Act (2006). Here is just some basic information about the procedures to see the differences among them.

- Open procedure: The public authority announces an intention to place public procurement to a unlimited number of suppliers in this type of procedure. The announcement is information for the suppliers to submit their offers and prove the accomplishment of the qualification.
- Negotiated procedure without publication (NPWP): There are several reasons when this procedure can be used.
  - If there were no offers or only unsuitable offers in previous competition (open procedure, restricted procedure, simplified procedure bellow threshold or competition dialogue). Then this procedure can be used. Also, the competition requirements cannot be changed substantially and the procedure is launched immediately after canceling the previous procedure.
  - This procedure can be also used if the public procurement can be fulfilled only by a specific supplier (technical or artistic reasons, protection of exclusive rights or specific juridical directive) or if the time reasons do not allow to assign regular open procedure or another type of procedure.
  - NPWP can be used in the public procurement on the delivery if
    - the product is produced only for research or development.
    - it is an additional product from the same supplier. NPWP can be used when the change of the supplier would cause buying product of different technical parameters and lead to the lack of interoperability or cause troubles in maintenance.
    - the product is purchased in the commodity stock market.
    - the product is purchased in very favorable terms from the supplier (company) which is in liquidation.
    - the product is purchased for the price that is significantly lower than the market price and the price is offered by a supplier only for a limited time.
  - NPWP can be used in the public procurement of the services if

    - ∗ the services were not in the original contract, their need was not predictable and they are necessary to provide the original services. (the additional services are given to the same supplier, the additional services cannot exceed 30 % price of the original procurement)

- Negotiated procedure with a publication (NPWP*): This procedure can be used if in previous competition (open procedure, restricted procedure, simplified procedure bellow threshold or competition dialogue) the offers were incomplete or unacceptable, the competition requirements are not changed substantially and the procedure is launched immediately after canceling the previous procedure.
- Proposal contest: This procedure is used when the authority acquires a proposal, project or plan. The proposals can be written or graphic. The law knows open or restricted proposal contest. This procedure type is used mainly in architecture, civil engineering or data processing.
- Competition dialogue: This procedure can be used if the public procurement is complicated and the using of an open or restricted procedure is not possible. The public procurement is complicated if the public authority is not able to objectively determine technical specification, legal or financial demands.
- Restricted procedure: The public authority announces an intention to place public procurement to an unlimited number of suppliers in this type of procedure. The announcement is information for the suppliers to make a request for attendance in the restricted procedure and prove the accomplishment of the qualification. Then those who fulfill the qualification are asked to submit their offers.
- Simplified procedure below the threshold: In this type of procedure the public authority asks at least 5 suppliers to make their offers and prove the accomplishment of the qualification. The public authority cannot demand the same circle of firms repeatedly if there are no special circumstances. The price for this type of procedure has to be higher than 2 000 000 CZK and lower than 3 395 000 CZK (for the Czech Republic and State contributory organizations) or 5 244 000 CZK (for the local governments and city contributory organizations).
- Exception from the directive: This type of procedure is really similar to the NPWP.

Now, when the basic information about the procedures is known, we can look at the results of the analysis. Table 6.1 shows usage of different procedure types. We can see that there are 3 procedures that are used more than the others (NPWP, open, and simplified below threshold). We can see that the most transparent open procedure was used in 40.5% cases. The simplified procedure below the threshold, which is dependent on the financial limits, was used in almost 19% cases. The NPWP was used in 31% cases. There are reasons for the use of the NPWP. Some of them, concretely authorship rights exclusivity and technical exclusivity, is used in 76.4% cases. The procurements placed by NPWP: 3 out of 4 is placed by this method because of the authorship or technical exclusivity.

This is similar to the results in Centrum aplikované ekonomie (8/2014). The study explores the NPWP in the public procurements from years 2006 to 2014. There are two

main findings for us. First, the researchers found out that two most used reasons for the NPWP are authorship rights and technical reasons which are caused by the mistakes of the contract owners. And second, the most problematic fields with mistakes of the contract owners are building industry and IT sector.

Therefore, these procurements could suffer from vendor lock-in.

Table 6.1: Number of contracts in different procedure types

Tender procedure type	Number of contracts	(%)
NPWP	3 974	30.99%
NPWP*	628	4.90%
Open	5 195	40.52%
Proposal contest	27	0.21%
Competition dialogue	14	0.11%
Restricted	119	0.93%
Exception from the directive	332	2.59%
Simplified below threshold	2 394	18.67%
Not fill out	139	1.08%

Source: own computation

Next, we look at the procedure types financially. Table 6.2 shows us expenses on procedure types. The previous table (6.1) shows that 3 types of procedure are used more than the others. One of them, the simplified procedure below threshold had almost 20% of all contracts. But table 6.2 shows that it is worth of 4.35 bn CZK which corresponds to 3.26% of expenses. It means that financially it is not that big. The open procedure is used more than the NPWP but the price of the contracts in the open procedure is lower than the price of the contracts in NPWP. The contracts in the open procedure worth of 53.8 bn CZK and the percentage share is same if we look at the number of contracts or the price of the contracts, 40%. On the other hand, the NPWP was used in 31% cases but the procurements worth of 62.32 bn CZK which is approximately 47% of all expenses. Thus, the NPWP is used less often but the contracts worth more than the contracts in open procedure.

Another division of the public procurements is according to the criterion type. There can be used only price as a criterion (price criterion) or multiple criterion can be used (it can also include price but not as the only criterion with 100% weight). Tables 6.3 and 6.4 shows that the price criterion was used evidently more than the multiple criterion. The price criterion was used in almost 68% cases in the open procedure and in the NPWP it was even 70%. The usage of the price criterion could also be the reason for vendor lock-in because it does not take other criterions into account, such as quality of the system.

Next, table 6.5 is devoted to the financing with the EU funds. We focus only on the NPWP and open procedure because these procedure types cover most of the expenses. We can see that total expenses on the NPWP were approximately 62.32 bn CZK but the EU funds were used only in the contracts worth of 3.54 bn CZK, which is 5.68%. On the other hand, total expenses on the transparent open procedure were 53.8 bn CZK and the EU funds were used in the contracts worth of 18.77 bn CZK, which is 34.88%. So the most transparent

Table 6.2: Expenses on different procedure types

Tender procedure type	Final price (bn CZK)	(%)
NPWP	62.32	46.68%
NPWP*	6.84	5.12%
Open	53.80	40.30%
Proposal contest	0.23	0.17%
Competition dialogue	0.84	0.63%
Restricted	1.73	1.30%
Exception from the directive	2.89	2.17%
Simplified below threshold	4.35	3.26%
Not fill out	0.49	0.37%

Source: own computation

Table 6.3: Multiple criterion in different procedure types

Tender procedure type	Multiple criterion	(%)
NPWP	1 182	(9.22%)
NPWP*	257	(2.00%)
Open	1 669	(13.02%)
Proposal contest	27	(0.21%)
Competition dialog	14	(0.11%)
Restricted	53	(0.41%)
Exception from the directive	92	(0.72%)
Simplified below threshold	532	(4.15%)
Not fill out	83	(0.65%)

Source: own computation

Table 6.4: Price criterion in different procedure types

Tender procedure type	Price criterion	(%)
NPWP	2 792	(21.78%)
NPWP*	371	(2.89%)
Open	3 526	(27.50%)
Proposal contest	0	(0.00%)
Competition dialog	0	(0.00%)
Restricted	66	(0.51%)
Exception from the directive	240	(1.87%)
Simplified below threshold	1 862	(14.52%)
Not fill out	56	(0.44%)

Source: own computation

Table 6.5: Expenses and financing with EU funds

Tender procedure type	Expenses (bn CZK)	EU funds (bn CZK)	(%)
NPWP	62.32	3.54	5.68%
NPWP*	6.84	1.09	15.88%
Open	53.80	18.77	34.88%
Proposal contest	0.23	0.21	90.83%
Competition dialog	0.84	0.40	47.20%
Restricted	1.73	0.23	13.04%
Exception from the directive	2.89	0.94	32.38%
Simplified below threshold	4.35	1.29	29.59%
Not fill out	0.49	0.04	8.03%

Source: own computation

open procedure is financed more often than the less transparent like NPWP. Thus it looks that EU funds lead to the transparent spending in IT which could lead to the lower lock-in.

To sum this up, the most used procedure types were open procedure and NPWP. More expenses were used on open procedure than on NPWP. The public procurements are competed more with the price criterion than with multiple criterions. The financing with the EU funds is more often in the open procedure. The NPWP was financed with EU funds just rarely.

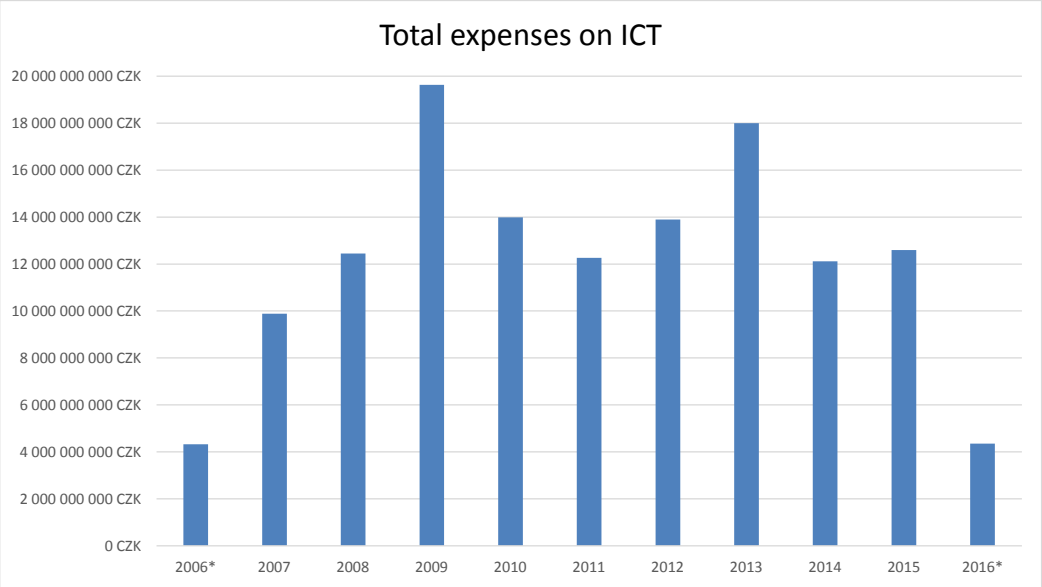
6.1.2 Analysis according to time

The previous analysis focuses only on the procedure types and how the expenses, the number of contracts and EU funds are divided among them. Now, we look at the expenses and EU funds through time.

If we look at the figure 6.1, we can see total expenses for each year. The peak expenses were in years 2009 (19.6 bn CZK) and 2013 (18 bn CZK). The peak in 2013 can be explained by the public procurements on the Information System of Data-Mail Boxes (1 contract with final price 1.75 bn CZK) and the Monitoring system of European funds for years 2014-2020 (one contract with final price over 0.5 bn CZK). The second peak, in 2009, can be again explained by the public procurements on the Information System of Data-Mail Boxes (2 contracts with final price 2 bn CZK) and by the procurement of the Ministry of finance for the Integrated information system State treasury (1 contract with final price 2.1 bn CZK). So the peaks can be mainly explained by the big contracts for the Information System of Data-Mail Boxes (2 bn CZK in 2009 and 1.75 bn CZK in 2013) and the contract for the State treasury (2.1 bn CZK in 2009).

Next comparison is of the procedure types and the EU funds. Concretely the two most used procedure types (open procedure and NPWP) and EU funds. From figure 6.2 we can see that public procurements with NPWP were financed with the EU funds in minimum cases and it is declining since 2012. Almost all expenses with NPWP were financed by national

Figure 6.1: Total expenses on ICT



Source: own computation, *not complete datasets

budget, without EU funds. On the other hand, the open procedure is financed more every year since 2008 till 2014, with a little decline in 2012 and 2015.

We can also see from the figure that spending in the open procedure is bigger, since 2014 than spending in the NPWP. Thus more spending in the open procedure could lead to the lower lock-in in the future. This will be seen in the next years.

To sum this up, the peaks in expenses can be explained by some big contracts (big price) which happened that year. There is a tendency for more usage of the open procedure in recent years and the decline of using the NPWP. The last thing is that the public procurements in open procedure are more financed with the EU funds.

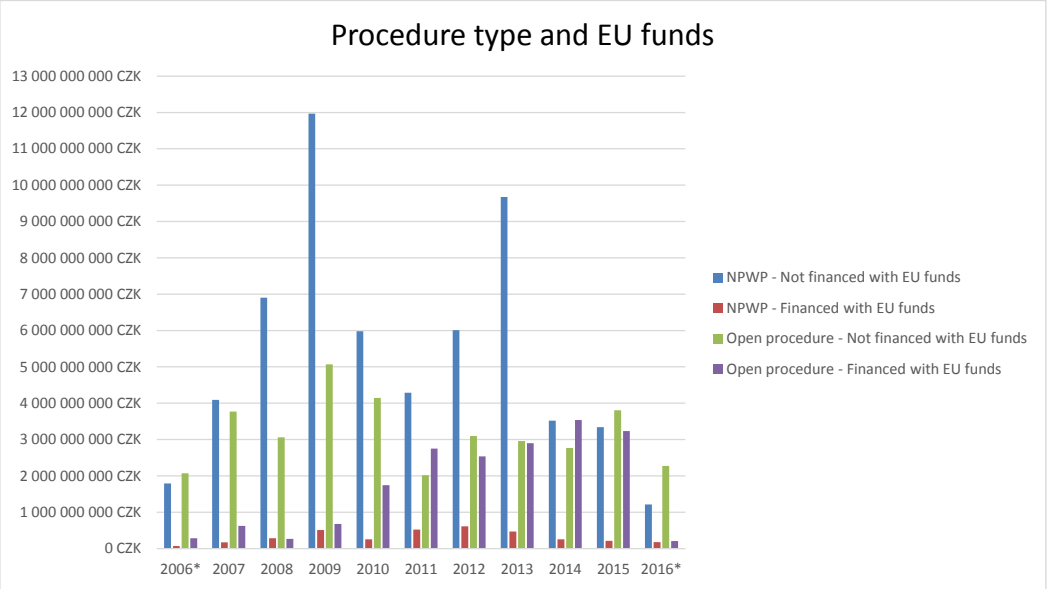
6.2 Hypotheses

The previous section was devoted to the descriptive statistics. Some basic information about the dataset and the procurements were mentioned. These things include the price of the procurements, tender procedure types or information about the EU funds. This section is devoted to the selection of the procurements, calculation of vendor lock-in rate for the regression and concretization of the hypothesis.

6.2.1 Sample of the procurements

The initial procurements have to be found for the analysis. They are manually selected this way: First, the procurements with no title and procurements with no tender procedure type are filtered out (the reason is that with no title the procurement cannot be paired with

Figure 6.2: Procedure type and EU funds



Source: own computation, *not complete datasets

other procurements (information systems) and the tender procedure type is needed for other calculations). Then the procurements are filtered for each individual office and arranged by date. Afterwards the information system or the procurement for certain service support is selected and then the initial procurement is manually found and picked, if the procurement is available (e.g. There are available procurements for the information system X in years 2015, 2013, 2012, 2011 and 2009. The initial procurement from 2009 is picked.). This method is used and leads to the selection of 100 procurements. Thus it is not a random sample owing to this method of selection.

Availability problem

The availability is a really big problem. The public procurement Act (2006) took effect in July 2006 and the public procurements have to be published since this date. But every procurement which was competed before this date is not in the database. This brings us the problem with the accessibility of the initial procurements (e.g. There are available procurements for the information system X in years 2015, 2010, 2007 and 2006. It can be seen, from the name of the procurement, that in 2006 it is just follow-up procurement but not the initial procurement. So we have in the database only the follow-up procurements. Then the procurement is not picked because it is not the initial one.).

This brings us a problem. We cannot use these procurements in our analysis even if they obviously suffer from some level of vendor lock-in (the same company is still delivering the information system or the follow-up procurements are mostly in the NPWPs).

This problem with availability is not some kind of a rarity in the dataset. Almost every big public office (ministries, regional cities and their offices, state control companies, etc.)

have at least one (but mostly more than one) information system which is older than 11 years, thus the initial procurement is not available, and it is delivered by the same company for the whole period of publishing the procurements.

Our sample consists of 100 procurements for the analysis. We could have at least a twice as big sample (maybe even bigger) if the data about the initial procurements were available. We cannot use at least 148 information systems which cost almost 14.5 bn CZK since 2006 (it corresponds to 11% of all expenses on ICT since then). Thus our sample consists of information systems which are 11 years old or younger. Then the analysis brings us results only for the systems which were competed during this period.

6.2.2 Vendor lock-in

The sample of the procurements for testing is ready. Now, the lock-in rate for each of these initial procurements has to be identified. In chapter 3.1 we had a definition for lock-in as "long-term dependence on a particular supplier." Dependence on a supplier also means that in the follow-up procurements there is small or even no competition. Thus for the calculation of lock-in rate we use the variables that include suppliers and procurements without competition or with one bid (because that is no competition). The equation includes these variables:

- **Same company:** This variable is percentage ratio between a number of follow-up procurements delivered by the same company and all follow-up procurements.
- **NPWPs:** This variable is percentage ratio between expenses on follow-up procurements in NPWP and all expenses on follow-up procurements. (procurements in NPWP also covers procurements in other procedure types with only one bid because that are probably procurements written specifically for that one supplier)

Summarizing these variables we get following equation:

$$\textit{Lock-in rate} = \textit{Same Company} + \textit{NPWPs}$$

This equation is used for calculation of the lock-in rate for each of the initial procurements. Then our initial procurements in the dataset have lock-in rate from 0 to 2. The value of 0 has the procurement where follow-up procurements are not in NPWP (or with one bid) and are not delivered by the same company. On the other hand, the value of 2 has the procurement where all follow-up procurements are in NPWP (or with one bid) and are delivered by the same company.

Next step is to define our hypothesis for testing.

6.2.3 Concretization of hypothesis

The primary aim of this study is to figure out if some criterions of the public procurements lead to higher vendor lock-in rate or not and if higher vendor lock-in rate leads to the higher profit of the suppliers. The criterions will be examined by the ordinary least square (OLS) regression. The profit hypothesis is about comparing two groups of companies to find out the differences between them.

The hypotheses are following:

H1: Public procurements competed only with the price criterion tend to higher lock-in rate.

In the previous analysis, we found out that price criterion is used significantly more than multiple criterion (in almost every procedure type). So the only criterion is price and things like quality or interoperability are not taken into account. This hypothesis should show if this way lead to higher lock-in rate or not.

H2: Public procurements financed with the EU funds tend to lower lock-in rate.

In the previous analysis, we found out that EU funds are connected mainly to the open procedure. Thus it looks that EU funds lead to the transparent spending and the possibility of lower lock-in rate. This hypothesis should figure out if this is true or not.

H3: Public procurements with higher number of bids tend to lower lock-in rate.

This hypothesis should figure out if more bidders (more competitive public procurement) lead to the decrease of vendor lock-in rate.

H4: Higher vendor lock-in rate leads to higher profit of the suppliers.

This hypothesis should show if locking yourselves to a specific supplier lead to higher profit of that supplier.

For the 3 hypothesis above (H1 - H3) we then have this equation:

$$\textit{Lock-in rate} = \beta_0 + \delta_1 * \textit{EU funds} + \delta_2 * \textit{Price competition} + \beta_3 * \textit{Bidders count} + \beta_4 * \textit{Size of public office} + \delta_5 * \textit{Another lock-in} + \epsilon$$

- Size of public office: Public offices are divided into 3 groups based on their average annual expenses on ICT. The value of this variable equals to the number which corresponds to the group.
  - 1 - small (less than 5 000 000 CZK)
  - 2 - medium (5 000 000 CZK - 27 000 000 CZK)
  - 3 - large (greater than 27 000 000 CZK)
- Another lock-in: This variable is either 0 or 1. It equals the value of 1 if the supplier of the initial procurement has another lock-in (e.g. it is the long-term supplier of one system in the same or another public office). Otherwise, the variable is 0.

Profit hypothesis

The hypothesis about the profit is calculated separately. It is about comparing 2 groups of companies from our sample of initial procurements. The indicator measures the value of the follow-up procurements in NPWP (it also covers procurements in other procedure types with only one bid) over the one year turnover of the company.

$$indicator_i = \frac{\sum_{k=1}^{n} (Follow{-}upNPWP)_k}{Turnover_{2012}}$$

where $\boldsymbol{n}$ is the number of follow-up procurements in NPWP and $\boldsymbol{i}$ represents individual companies. The year 2012 for the turnover of the company is selected because it is the year when the biggest number of initial procurements begins. The source of the financial data is CEKIA (Bisnode) company database which includes information about all Czech companies.

Only follow-up procurements in NPWP are used. The overall sample is 43 companies. We then create 2 groups with low lock-in rate (0-1.5) and high lock-in rate (1.5-2). We use lock-in rate value which we calculated previously. The sample consists of 10 companies with low lock-in rate and 33 companies with high lock-in rate.

These two groups are then compared with the median value. We use a nonparametric Mann-Whitney test for comparing two groups, as it was used in Centrum aplikované ekonomie (8/2011).

For this hypothesis we verify this statement:

H_0: Median values of the indicator for both groups are not different thus the rate of lock-in does not influence the profit.

In case that this statement will not be verified and median values will be significantly different then we can incline towards this statement:

H_1: The median value of the group with higher lock-in rate is significantly higher thus the companies have higher profit.

We have our hypothesis and now we can see the results.

6.3 Results and discussion

As was already mentioned, two methods are used for the calculations. The 3 hypothesis are tested through the OLS regression and the profit hypothesis is tested through the nonparametric test.

First, we look at the results of the OLS regression which was used to test the following hypotheses:

- **H1: Public procurements competed only with the price criterion tend to higher lock-in rate.**
- **H2: Public procurements financed with the EU funds tend to lower lock-in rate.**

- **H3: Public procurements with higher number of bids tend to lower lock-in rate.**

We tested these hypotheses on the selected 108 procurements and the results can be seen in the following table 6.6.

Table 6.6: Results of the OLS regression; dependent variable: Lock-in rate

Explanatory variable	OLS coef.	Standard error	t-test	
EU funds	-0.241	0.146	-1.65	
Price competition	0.044	0.133	0.33	
Bidders count	-0.098	0.040	-2.43	**
Size of public office	0.025	0.153	0.17	
Another lock-in	0.099	0.144	0.69	
Constant	1.599	0.437	3.66	***

Source: own computation; $R^2 = 0.1530$; note: The level of significance is denoted by a number of stars: 1 star means 90% significance level, 2 stars mean 95% significance level and 3 stars mean 99% significance level.

Accordingly, we can rewrite the results into the equation:

$\widehat{Lock-in rate} = 1.599 - 0.241 * EU\,funds + 0.044 * Price competition - 0.098 * Bidders count + 0.025 * Size\,of\,public\,office + 0.099 * Another$ lock-in

The interpretation of the results follows:

- According to the results, explanatory variable Price competition has the sign as we expected but was not found to have a significant effect on lock-in rate in our model. Thus it means that we cannot say that the price competition leads to higher lock-in rate.
- Neither the hypothesis about the EU funds was confirmed. The sign of the variable is also as we expected but the variable was not found to have a significant effect on lock-in rate in our model.
- The hypothesis about the number of bids was confirmed. A higher number of bids leads to the lower lock-in rate as expected. Thus the procurements which are more open to competition have lower lock-in rate.

Next, we have the profit hypothesis.

- **H4: Higher vendor lock-in rate leads to higher profit of the suppliers.**

Table 6.7 shows basic descriptive information about the groups. We see that median value for higher lock-in rate is 13.46% and it is about 3.5 percentage points bigger than the median value for the other group.

Table 6.7: Descriptive statistics for lock-in rate groups

Variable	Number of observation	Median value
Lock-in rate 0-1.5	10	10.01%
Lock-in rate 1.5-2	33	13.46%

Source: own computation

Table 6.8: Results for Mann-Whitney test

Value of the test	p-value
0.460	0.6455

Source: own computation

Now we take the test itself. As was said above, we use a nonparametric Mann-Whitney test as in Centrum aplikované ekonomie (8/2011).

Table 6.8 shows us the results of the test that the companies in the group with higher lock-in rate have higher profit. We reach high p-value thus we accept the H_0. Thanks to these results we say that the rate of lock-in does not influence the profit.

To sum up we did not prove the hypotheses about the EU funds and price criterion. The signs of these variables were as we expected but the variables were not found significant. Thus the level of lock-in rate is influenced neither the competition with price criterion nor the financing with the EU funds. Also, the profit hypothesis was not proved. The reason for all these results could be that we have a small sample which is the consequence of unavailability of the initial procurements (As we said we could not use at least 148 information systems because the initial procurements are not available in the dataset.). The only hypothesis we have proved is about the number of bids. A higher number of bids leads to the lower lock-in rate. Thus the procurements which are more open to competition have lower lock-in rate.

7 Conclusion

This paper was devoted to the vendor lock-in in public procurements on ICT in the Czech Republic. This problem of vendor lock-in does not trouble only the Czech Republic but it troubles all the European Union. The public sector in the EU loses around €1.1 billion per year due to this problem, according to the Commission (6/2013a).

We explained the term vendor lock-in in ICT in general and presented some situations when the customers can be dependent on the suppliers (e.g. due to the author rights, availability of the source codes, lack of documentation, etc.). Then some examples from the Czech Republic were introduced. These procurements led to the peak expenses in recent years. Then we introduced experience from Massachusetts where they adopted open standards to avoid vendor lock-in and have more control over the information technology. The results of this policy were the expansion of open standards and encouragement other governments to adopt open standard policies.

The survey, Economics (2012b), among the procurers (public authorities) and the suppliers about the procurement practices across the EU showed us that there are different opinions on the use of standards, writing open tenders using technology-neutral language or referring to specific brand names. The suppliers claim that certain standards, specifications or specific products are demanded. The procurers claim the opposite. The reason for this could be that procurers (public authorities) have a lack of expertise.

Then we introduced some theoretical points how the lock-in could be prevented. These points include things like developing ICT strategy, elements which should be part of the contract documentation and usage of open standards and open-source software. One recommendation to lower lock-in is that procurement can be divided into small procurements in order to avoid building giant ICT systems with one supplier. Another recommendation concerns about the competition by the lowest price criterion. The procurements on ICT should not be competed like this. They should be evaluated according to quality, interoperability, user-friendly control or using the open standards or open source software. According to the (Committee 4/2006), this principle of openness is important because it leads to better competition, efficiency, lower long-term expenses on ICT and encourages innovative solutions.

In the empirical analysis, we tried to find out if some criterions of public procurements lead to higher lock-in rate or not. Another task was to find out if higher vendor lock-in rate leads to the higher profit of the suppliers.

Firstly we focused on the description of the data. We found out that price criterion was used more than multiple criterions and every third procurement was funded with the help of the EU funds. The most used tender procedure types were the open procedure (the most

transparent) and NPWP (the least transparent). The open procedure was used more than NPWP but financially it was the opposite. Next finding was that open procedure was used more in recent years. So it could lead to the lower lock-in in the future.

Next, we had to select the original procurements for the analysis. During this selection, another important problem was discovered. Many of the initial procurements were not found because the data about the procurements have to be published since 2006. Thus it means that many of the IT systems in the public sector are 11 years old or even older. We could not find the initial procurements for at least 148 information systems. During last 10 years these systems cost at least 14.5 bn CZK which is 11% of all ICT expenses for last 10 years.

We tested 3 hypotheses (about EU funds, price criterion, and a number of bids) through the OLS regression. All 3 variables have the signs as we expected but only the number of bids was found significant. Thus we proved that higher number of bids leads to lower lock-in rate. We did not prove that financing with EU funds tends to lower lock-in rate and that using only price criterion tend to higher lock-in rate. Then we tested the hypothesis that higher vendor lock-in rate leads to higher profits of the suppliers through the nonparametric Mann-Whitney test. But the hypothesis was not proved. The reason for these results could be that we have a quite small sample due to the unavailability of the initial procurements.

This thesis has shown that more competitive environment in initial procurements leads subsequently to the lower lock-in rate. We also found out that public offices suffer from oldness of information systems (11 years old or older). Nevertheless, in the future, there is a chance to have a bigger sample because all information about new information systems will be in the Information System on Public Contracts. Thus the results could be different then.

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